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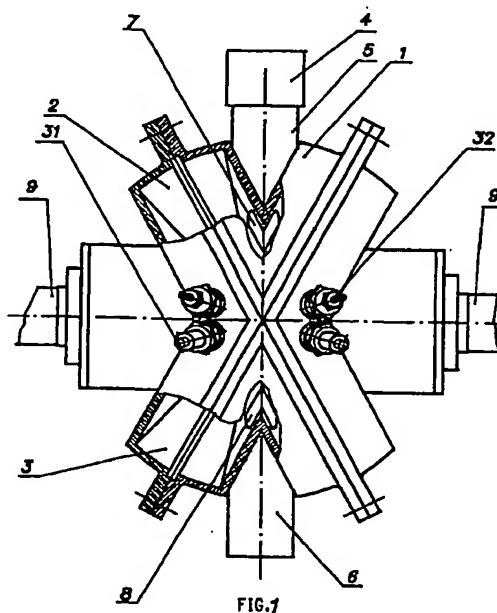
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(54) Internal combustion rotor-piston engine

(57) An internal combustion rotor-piston engine comprises a main body (1) embedding two intersecting torus-like cavities (2,3). Each cavity guides two arc-shaped pistons. A main driving shaft (9) comprises a central spherical part allocating four slots under a certain angle with the axis of the main driving shaft. Each of said four pistons has two butt-end surfaces and is connected with the main driving shaft by four coupling devices comprising an arc-shaped sector moving along the corresponding slot on the spherical part of the main driving shaft and a pin extending into the piston, for transmitting torque to the main driving shaft. The internal combustion rotor-piston engine further comprises a common inlet window (7) for the two intersecting cavities and a common outlet window (8) for the two intersecting cavities joining an outlet pipe, characterised in that each piston comprises a built-in chamber of combustion on the rear part thereof.



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## Description

[0001] The present invention belongs to mechanical engineering and particularly to the engine-building industry and can be used in transportation industry.

[0002] From SU-A-1772 375, it is known to provide a rotor-combustion engine with two intersecting circular cylinders with pistons inside, two diametrically opposite input/output or inlet/outlet chambers, one pair of each per cylinder, a driving shaft and a synchro system consisting of two hinges each having a cylinder cam and a disk with a through hole, the axis thereof being perpendicular to the longitudinal axis of the cylinder, the body having a spherical cavity and two through diameter channels with conical section, the driving shaft having a central spherical part, two opposite conical and two cylinder parts attended by corresponding section of a body cavity. In the central spherical part of the driving shaft, there is a through slot tilted to the shaft axis and being perpendicular to the through hole containing the cylinder cam.

[0003] Deficiencies in the design of this engine are the unbalanced mechanism and the difficulty to obtain a gas sealing contacts of pistons during the phase of mutual contact because of the different velocity of their movements (the velocity of the piston which is running is higher of the velocity of the piston which is overtaken).

[0004] From WO-A2-98/19060 an internal combustion rotor-piston engine is known which has the main body with two intersecting circular cylinders in which are located the pistons, main shaft being allocated in the central spherical shape of the body, in each cylinder there are two pistons, in the central spherical part of the main shaft there are slots each one under a certain angle with the axis of the main shaft, the pistons connected with the main shaft through hinges each of them including a sector part which is allocated with the possibility to move inside the slot on the spherical surface of the main shaft and a pin which is allocated in the hole of the pistons and the chamber of combustion are inside the slots.

[0005] The present invention counts on the following disadvantages of this engine:

1. The configuration with the chambers of combustion allocated inside cavities of the main shaft is very far from the optimal (spherical or cylindrical), and the ramification make them non effective with the tendency of the detonation. Beside this such location of chamber of combustion is not effective for their cooling which could cause overheating of the main shaft and failure of the engine.

2. The reduction of the output power because using part of the working body for the compensation of the centrifugal forces of the rotating pistons.

3. Interfering sides of the pistons make the engine

not working because of the different velocity of pistons during the interaction phase lasting about 37 angular degrees; running pistons is moving with deceleration and overtaking piston is moving with acceleration, and despite the small difference in velocity, the final result is a grip of the pistons and the failure of the engine.

4. Because of the external preparation of the combustion mixture and because of the different pressure of exhaust gases and combustion mixture depending on working regime, part of combustion mixture can flow through the outlet at high regimes and exhaust gas can flow through inlet window at middle and low regimes.

[0006] The object of the present invention is to provide a new engine according to the opening portion of claim 1 which simplifies the construction and extends the reliability of the engine and its power and both reduces the consumption and the toxic components in the exhaust gas.

[0007] This object is settled by claim 1. Advantageous developments may be taken from subclaims.

[0008] The invention provides an internal combustion rotor-piston engine that has the main body embedding two intersecting torus-like cavities (defined as cylinder only because of their function and not because their geometrical shape), the two cylinders allocating two arc shaped pistons each, a main driving shaft with its central spherical part allocated into a corresponding spherical cavity in the body, in the spherical central part of the main shaft there are four slots under a certain angle with the axis of the main shaft, such slots connected each other by calibrated holes, pistons running inside cylinders are connected with the main shaft by four coupling devices (shortly defined as hinges) composed of a solid arc shaped sector moving along the corresponding slot on the spherical part of the main shaft and of a pin that is allocated in the hole of the corresponding piston, at an extremity of the piston there is the combustion chamber having a circular hole on the external surface of the piston and a communication hole on the nearest butt-end of the piston, the profile of the cuts of the butt-end of the pistons are obtained in accordance with the laws of cinematic in order to create a proper surface of interference, in correspondence of the sharp angles of these profiled butt-end are inserted sealing plates, inlet and outlet windows are in common for the two intersecting cylinders and increasing of the efficiency can take advantages from direct injection with an automatic compensation at different regimes realized by a channel system created inside the spherical part of the main driving shaft.

[0009] To understand the invention and referring to the drawings, the following explains an example of the internal combustion rotor-piston engine with chambers of combustion inside the pistons:

[0010] Further details, features and advantages of the invention may be taken from the following description of an embodiment of the invention.

- Fig. 1 shows a side view of an embodiment of the engine according to the invention;
- Fig. 2 shows an exploded view of the embodiment according to Fig. 1, but without the casing;
- Fig. 3 shows a schematic view of the piston movement of the embodiment according to Fig. 1 and 2;
- Fig. 4 is an enlarged view of a detail I of Fig. 3;
- Fig. 5 is a view corresponding to Fig. 3, but shortly thereafter; and
- Fig. 6 is another view of the detail according to Fig. 4, but shortly thereafter.

[0011] The engine has an assembled body 1 [Fig.1] made of four parts. In the body 1 there are two intersecting torus-like cavities 2,3 - defined cylinders because their function - characterized by a cross section having the shape of a part of annulus with is central angle of 30 angular degree. The inlet pipe 5 supplying the inlet windows 7 is connected to a corresponding forcing device 4. The outlet windows 8 are connected to the exhaust pipe 6. Inlet windows 7 and outlet windows 8 are in common for both intersecting cylinders 2,3 and are placed in correspondence of their two diametrically opposite crossing points. Inside the body 1 there is allocated the main driving shaft 9 with a central spherical part 10 [Fig.2] and two opposite cylindrical parts 11,12. Four arc-shaped pistons 13 are arranged inside the two intersecting cylinders 2,3. Pistons 13 have two side surfaces 14, two specially profiled butt-end surfaces 15, and two external spherical surfaces. The two sides surface 14 and the external spherical surface 16 of the pistons 13 matches with the cross section of the intersecting cylinders 2,3 while the internal spherical surfaces of pistons matches with the spherical part 10 of the main driving shaft 9. Along the axis of the external spherical surface 16 of piston there is a jaw 17 running in the corresponding slots on the external surface of the intersecting cylinders 2,3 to minimize friction. In pistons there are holes 18 for the pins 19 of coupling devices -or hinges-20 to couple pistons 13 with the main shaft 9. Such hinges 20 made of a solid arc-shaped sector 21 and a pin 19.

[0012] Referring to the sense of rotation, on the rear part 22 of the piston 13 there is realized the chamber of combustion 23, which has two holes: a hole 24 on the external spherical surface 16 and another hole 25 on the nearest profiled butt-end surface 15. At the two sharp angles 33 [Fig.4,6] between the two profiled butt-end surface 15 and the adjacent side surfaces 14, there

is inserted a plate sealing 26, 27, one each sharp angle 33.

[0013] On the spherical part 10 of the main driving shaft 9 there are four slots 28 with an angle with the longitudinal axis of the main driving shaft 9. In the slots 28 are allocated the arc-shaped sectors 21 of the hinges 20. The insertion of the arc-shaped sector 21 into the corresponding slot 28 divides each slot in two parts G, K. One of the parts G forms the aerial cavity and it is connected with the other three via a channel 29 terminating with four calibrated holes 30. The other part K forms the oil cavity.

[0014] On the body there are two ignitions or heating candles 31 [Fig.1] and two injectors 32 for fuel. Alternatively, spark plugs 31 are provided.

[0015] The device (internal combustion rotor piston engine) is working in the following way:

[0016] During functioning the four pistons 13 [Fig.2] rotating inside the two intersecting cylinders 2,3 [Fig.1] are forming four cavities A, B, C, D [Fig. 3, 4, 5, 6] changing continuously their volume and position so granting the classical working phases of an internal combustion engine: suction, compression, expansion and exhaust.

[0017] Suction of charge in cavity B is terminated when the crossing piston 13 closes the inlet window 7 and immediately after it starts the compression of the charge. During the compression an extra portion of the charge enters into cavity B through its correspondent calibrated hole 30 [Fig.2]. This extra portion of charge is coming from the cavity G delimited from the piston opposite to the one delimiting the cavity B. The path of the extra portion of charge is than: cavity G, calibrated hole 30 correspondent to cavity G, channel system 29 inside the spherical part 10 of the main driving shaft 9, calibrated hole 30 correspondent to cavity B, cavity B. In such way the extra portion of charge passing through the channel system 29 inside the spherical part 10 of the main driving shaft 10 provides to the cooling of the shaft while increasing its own temperature and finally the temperature of the overall charge in cavity B that is also better fulfilled.

[0018] The quantity of the charge that enters cavities through the calibrated hole depends on the angular velocity of the main shaft 9: the higher is the velocity of the main shaft the less the charge which enters through the calibrated holes 30 into cavity A so allowing to control the fulfillment of the charge in the cavity. This improves features at the start and idle regimes and it decreases consumption and toxic exhaust at low and medium regimes.

[0019] At the beginning of the contact of the two crossing pistons 13 in cavity C it starts the injection of fuel by the injector 32. The fuel is mixed with the charge and under the influence of high temperature resulting from compression it evaporates.

[0020] The direct injection gives the possibility to optimize the preparation of the mixture increasing the effi-

ciency of the engine and reducing the toxicity of the exhaust. Beside this, by using the direct injection of the fuel into cavity C it eliminates the possibility to mix the mixture with the exhaust at the moment of simultaneous opening of inlet windows 7 and outlet windows 8 as it could be in case of an outside preparation of mixture. To reduce the probability of entering of exhaust into cavity B, the inlet windows 7 and outlet window 8 are well separated by locating them at opposite position into sharp angles formed from the intersecting cylinders 2,3.

[0021] As soon as the sharp angle 33 of one piston closes the hole 25 of the chamber of combustion 23 into the crossing piston, the mixture enters into the chamber of combustion 23 where the pressure and temperature are increasing so homogenizing the combustion mixture.

[0022] During the period of time from the beginning of contact of pistons 13 and closing of hole 25 a small portion of the charge, which quantity depends on angular velocity of the main shaft, enters into cavity B providing an increase of the energy of the charge into cavity under compression. This process for mixture preparation provides automatic control of the optimal proportion of charge and fuel mixture since the fuel quantity is constant. For example the reduction of the load increases the angular velocity of the main shaft which causes an increase of charge entering into combustion chamber: because of this the mixture becomes poorer, the power of the engine decreases. And the opposite: increasing the load it decreases the velocity of the main shaft and it consequently decreases the charge entering into the chamber of combustion so causing an enrichment of the mixture and an increase of the output power of the engine.

[0023] When the hole 24 of the chamber of combustion 23 reaches the ignition candle there is the ignition of the mixture and it starts the expansion phase. The profiled butt-end 15 of the piston 13 and its plate seal 26,27 inserted in correspondence of the sharp angles 33 interacting the correspondent surfaces minimizes the clearance during the exploitation of the engine.

[0024] The compressor 4 provides effective ventilation of the combustion chambers; it also cleans the rear part of the body 1 from exhaust so decreasing the temperature and the toxicity of the exhaust.

#### Claims

1. Internal combustion rotor-piston engine, comprising a main body (1) embedding two intersecting torus-like cavities (2,3) each guiding two arc-shaped pistons (13), a main driving shaft (9) comprising a central spherical part (10) allocating four slots (28) under a certain angle with the axis of the main driving shaft (9), with each of said four pistons (13) having two butt-end surfaces (15) and being connected with the main driving shaft (9) by four coupling devices (20) comprising an arc-shaped sector (21) moving along the corresponding slot (28) on the spherical part (10) of the main driving shaft (9) and a pin (19) extending into the piston (13), for transmitting torque to the main driving shaft (9), further comprising a common inlet window (7) for the two intersecting cavities (2,3) and a common outlet window (8) for the two intersecting cavities (2,3) joining an outlet pipe (6), characterised in that each piston (13) comprises a built-in chamber of combustion (23) on the rear part (22) thereof.
2. Internal combustion rotor-piston engine according to claim 1, characterized in that said built-in chamber of combustion (23) of each piston (15) comprises a hole (25) formed in the nearest butt-end surface (15) of the piston (13).
3. Internal combustion rotor-piston engine according to claim 2, characterized in that said hole (25) and said built-in chamber of combustion (23) are arranged adjacent to another piston which is close to the rear end of the piston when intersecting with its path of travel.
4. Internal combustion rotor-piston engine according to one of the preceding claims, characterized in that the built-in chamber of combustion (23) comprises a cylindrical hole (24) extending essentially radially through the piston (13).
5. Internal combustion rotor-piston engine according to one of the preceding claims, characterized by at least one sealing plate (27) arranged on the sharp angle (33) between the rear butt-end surface (15) and a side surface (14) of each piston, and preferably another sealing plate (26) arranged on the sharp angle (31) between the front butt-end surface and the respective other side surface.
6. Internal combustion rotor-piston engine according to one of the preceding claims, characterized by calibrated holes (30), adjoining a channel system (29) in the spherical part (10) for allowing ventilation between the slots during movement of the coupling devices (20) therein.
7. Internal combustion rotor-piston engine according to one of the preceding claims, characterized in that said inlet window (7) and that outlet window (8) are located on two diametrically opposite sharp intersections of the two intersecting cavities (2,3).
8. Internal combustion rotor-piston engine according to one of the preceding claims, characterized by a compressor (4) which is arranged on an inlet pipe (5) close to the common inlet window (7) of the two intersecting cavities (2,3).

9. Internal combustion rotor-piston engine according to one of the preceding claims, characterized in that a standard electrical or electronic control device is provided for controlling the direct injection and ignition.

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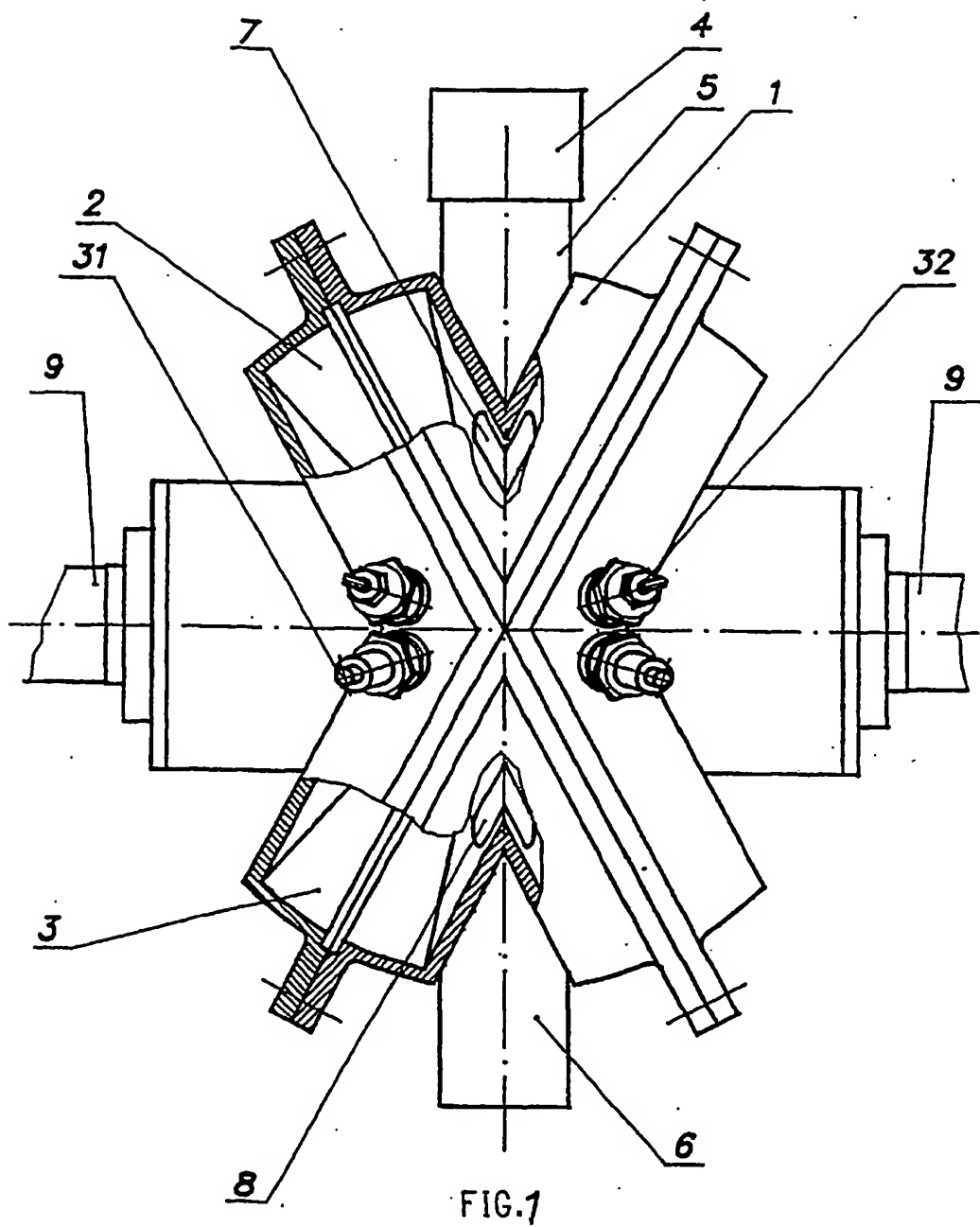
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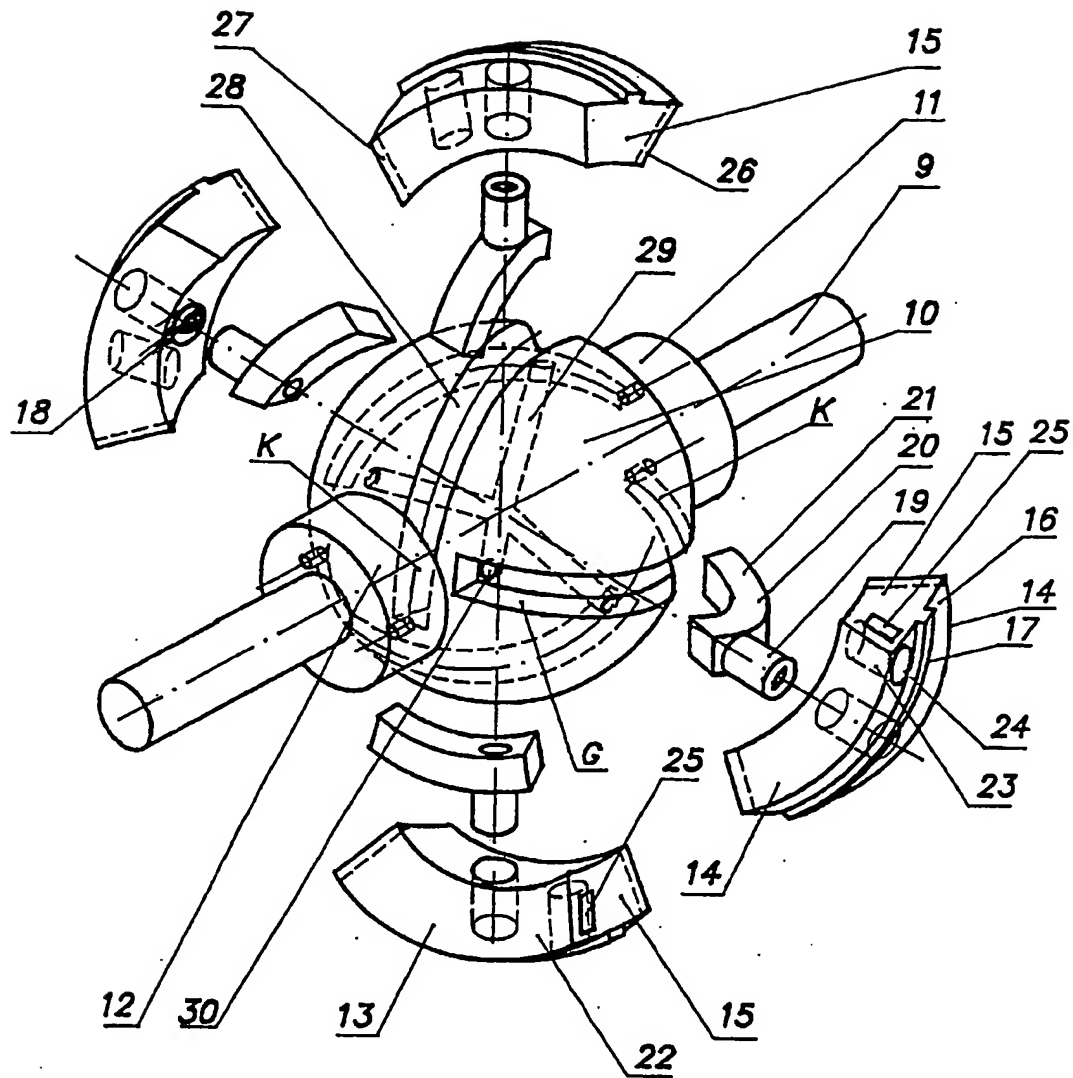
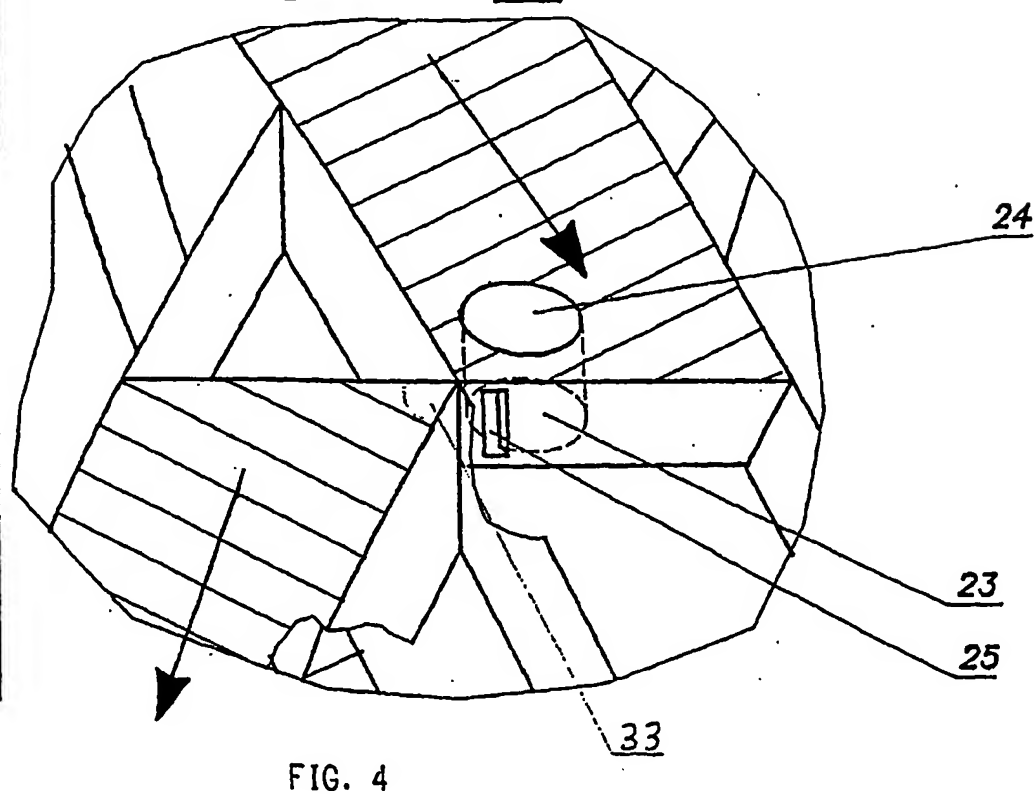
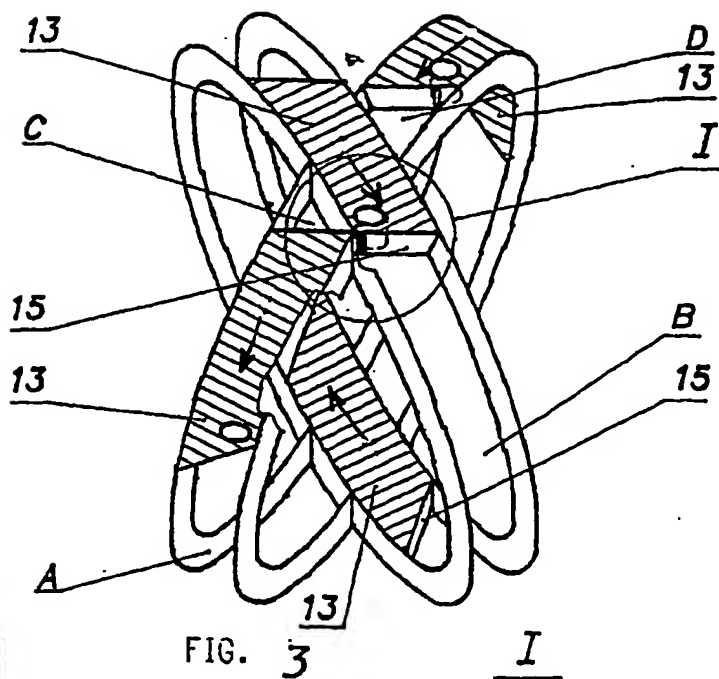


FIG. 2





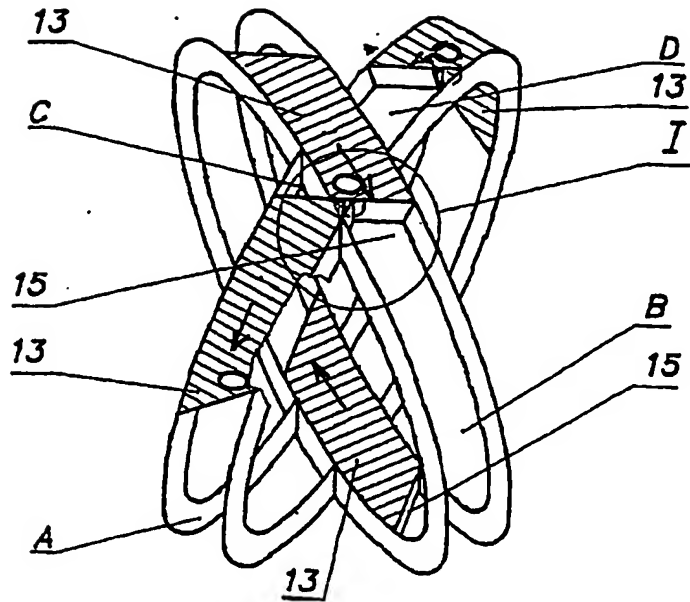


FIG. 5

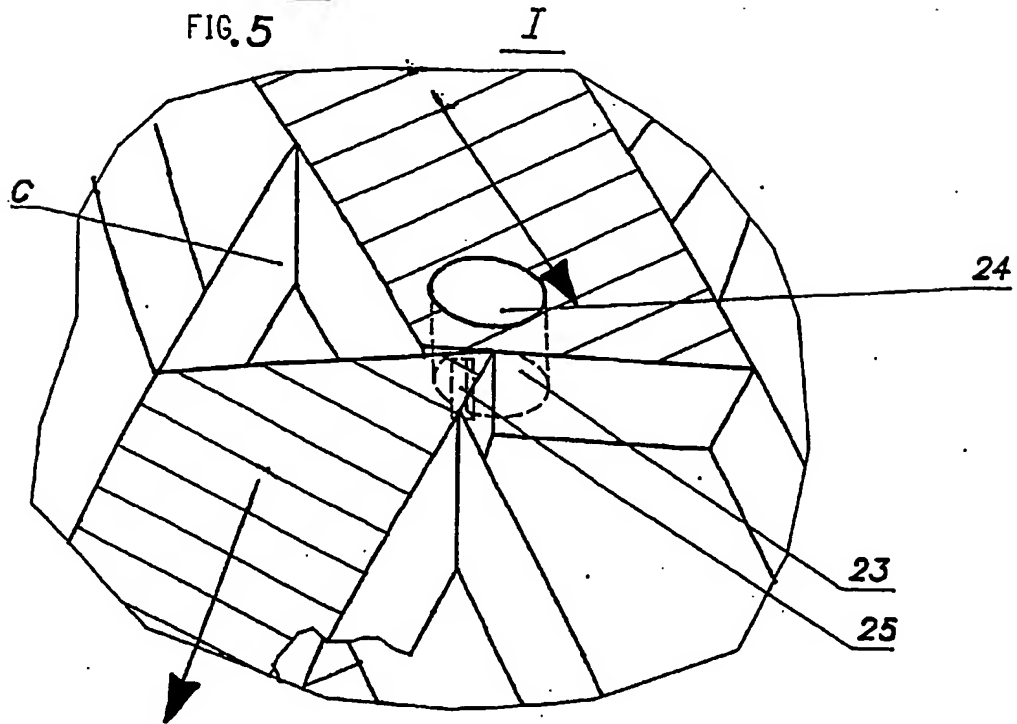


FIG. 6



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# EUROPEAN SEARCH REPORT

Application Number  
EP 99 11 8246

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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 December 1999	Examiner Kapoulas, T
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document	

EPO FORM 1503 03.02 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
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EP 99 11 8246

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